Dear Enemy: The Dynamics of Conflict and Cooperation in Open Innovation Ecosystems

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ABSTRACT

Open innovation ecosystems rely on cooperation among participating firms, but conflict also arises between participants. Yet, there is limited understanding regarding how interorganizational conflict influences ecosystem dynamics. We discuss a theoretical framework that explains how disagreements that reflect unanticipated changes in the value of contested technologies alter public, club, and private benefits for ecosystem participants and, thereby, shape their incentives to cooperate. We argue that firms are likely to increase cooperation after conflict arises when they are more technologically interdependent and have fewer outside options but otherwise are apt to reduce cooperation. Further, we propose that ecosystem participants can shape the degree of openness and the boundaries of the ecosystem to manage the implications of disagreements. Our arguments align with observations of the *dear enemy* recognition of cooperation among territorial biological species, which we argue also operates in organizational ecosystems.

Keywords: Interorganizational cooperation, networks, conflict, club benefits, private benefits, open innovation

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We are grateful for the feedback from Editor Janet Bercovitz, an anonymous referee, and the Special Issue Conference participants at the University of California Berkeley.

1. Introduction

Firms often choose to participate in open innovation ecosystems such as standards development organizations (SDOs), open-source software projects, technology consortia, and networks of R&D alliances to further the collective interests of the ecosystem as well as their own interests (Rosenkopf et al. 2001, von Hippel and von Krogh 2003, Simcoe 2012). Indeed, there is a remarkable amount of technological cooperation in these ecosystems even when conflicts arise among rival participants. For instance, all the while Samsung and Apple litigated the "patent trial of the century" (Elmer-Dewitt, 2012), Samsung continued to supply key components for Apple smartphones (Baj, 2015). Such cooperation in the face of conflict is surprising because existing research on interorganizational alliances suggests that when competitive interests clash, firms sever their cooperative ties (Seabright et al. 1992, Baker et al. 1998, Kim et al. 2006, Greve et al. 2010, Polidoro et al. 2011). Similarly, despite longstanding disputes over patent infringement and licensing terms, Qualcomm and Nokia continue to cooperate to achieve interoperability in the 5G mobile ecosystem[1]. This disconnect between theory and cooperative phenomena observed in open innovation ecosystems highlights the need to explain the unique competitive and cooperative dynamics that these ecosystems create.

To explain these phenomena, we draw inspiration from the *dear enemy* recognition expounded by evolutionary biologists (e.g. Hamilton 1964, Getty 1987, Temeles 1994, Griffin et al. 2004). The notion of dear enemy explains why under certain conditions cooperation can become an evolutionarily stable strategy even between natural enemies. In the realm of how cooperation evolves, scholars have recognized that there exist parallels between open innovation

[1] https://www.qualcomm.com/news/releases/2018/12/03/qualcomm-and-nokia-complete-5g-nr-mmwave-and-sub-6-ghz-over-air-ota

ecosystems and biological ecosystems: both biologists and organization theorists (e.g. Axelrod and Hamilton, 1981) use evolutionary game theory to illuminate how repeated interactions drive cooperation between enemies. We follow this lead by using the rationale of economic payoffs in repeated interaction settings to explain the *dear enemy* effect in open innovation ecosystems.

Open innovation ecosystems are broadly defined as networks or communities of firms connected by mutual interest in generating and using shared technological resources for value creation and appropriation (Iansiti and Levien 2004, Chesbrough, 2003). These collective structures or meta-organizations (Gulati, Puranam and Tushman 2012) take many forms including technology platforms, networks, and communities (Evans, Hagiu and Schmalensee 2006, Lerner and Tirole 2002). They transcend many technology sectors, although they are especially prevalent in information and communication technology industries. Some open innovation ecosystems are tightly connected through specific communication platforms, such as mobile phone operating systems that connect users of multiple equipment providers and service providers. Others are loose constellations of firms engaged in co-creation projects, such as alliance networks among biotechnology and pharmaceutical firms. Standards development organizations (SDOs) and open-source software (OSS) communities fall in the middle—they develop shared, interrelated technologies and protocols that support participants' products and technologies, but participants may range from direct competitors to complementors.

Within open innovation ecosystems, competition and disagreements between participants can lead to outright conflict. This recognition highlights an important point of departure in our framework from existing discussions of cooperation and conflict. A common perspective is that conflict tends to wreck cooperation. Research has shown that partners tend to exit relationships when there is friction (Greve et al. 2010, Polidoro et al. 2011). Moreover, violations of expectations tend to destroy trust (Gulati, 1995; Zaheer et al. 1998) and lead partners to distance themselves from violators or to seek revenge (Bies and Tripp 1996, Bradfield and Aquino 1999, Lount et al. 2008). This perspective is grounded in cooperative theory and research that has generally focused on dyadic strategic alliances and their implications (e.g., Dyer and Singh 1998, Arslan 2018). In the dyadic view, payoffs to cooperation inhere within the alliance. In contrast, open innovation ecosystems allow for cooperative payoffs to exist not only within dyads, but also coalitions of firms, and the broader ecosystem, which alter the nature of the strategic choice to cooperate.

The coopetition literature has suggested ways to isolate competition from cooperation to minimize the impact of conflict. Firms may organize internally to separate units or functions that have competitive linkages from those that have cooperative linkages, or they may oscillate over time between competition and cooperation. However, such strategies may be difficult to enact because they require low interdependence and buffers to safeguard interorganizational trust, or necessitate new organizational routines to minimize the spillover of conflict into the cooperative space (Hoffman et al. 2018). Furthermore, these notions assume that competition and conflict, unless managed and mitigated, will adversely affect cooperation.

The dear enemy perspective from evolutionary biology provides a contrasting perspective: despite conflict, cooperative outcomes can emerge in repeated interactions between proximate territory holders based on the principles of mutual gains, kinship and reciprocity (Axelrod and Hamilton 1981). The greater the shadow of the future and the cooperative payoffs, the more likely that cooperation rather than defection or exploitation will emerge as the stable equilibrium (Schelling 1960, Hirshleifer 1978, Axelrod 1984). This paradox of the dear enemy effect (Hamilton 1964, Getty 1987) opens the potential to explain cooperative outcomes in interorganizational ecosystems using economic rationale in repeated games.

Importantly, cooperation occurs because participants accrue private benefits such as the increasing adoption of their own technological innovations, club benefits that accrue from complementary interdependencies among a subset of firms in the ecosystem, and public benefits that all industry participants enjoy (cf. Farrell and Saloner 1988, Rysman and Simcoe 2008, Bar and Leiponen 2014, Jones et al. 2019). Private benefits depend on collective decisions concerning which technological solutions are broadly adopted and developed (Khanna et al.1998, Ostrom 2000, Farrell and Simcoe 2012, Simcoe 2012). Club benefits depend on the joint decisions of complementary firms to cooperate in a technological area of shared interest within the ecosystem. Public benefits are derived from private investments such that no-one can be excluded from open technologies, information, or infrastructure. Thus, firms enhance the value of the whole ecosystem as they invest in it to increase their club benefits and their private share of value (West et al. 2014). As in the coopetition stream of strategic management research, firms in open innovation ecosystems cooperate to create value and compete to capture value (Brandenburger and Nalebuff 1996, Hoffman et al. 2018).

A surge of litigation in the smartphone industry illustrates the dear enemy paradox in an organizational setting. The litigation often concerns licensing standard essential patents (SEPs) and infringement on product features (Lerner and Tirole 2015). Despite the increasing intensity of intellectual property litigation and retaliation through countersuits, firms such as Qualcomm and Nokia continue their cooperative relationships within standard development organizations (SDOs)[2]. This suggests that the private, club, and/or public benefits of cooperation persist in

[2] Cf. https://www.reuters.com/article/us-nokia-qualcomm/timeline-qualcomm-vs-nokia-patents-battle-idUSL257876620080225 retrieved in January, 2019.

open innovation ecosystems, as we will detail. Importantly, firms can engage in extended conflict in one domain, such as the protection of their patents, while continuing to cooperate in a related domain such as SDOs to take advantage of their complementary assets for future generations of the technology.

Apart from patent and licensing disagreements, conflict manifested in the forking of Open-Source Software (OSS) ecosystems may influence subsequent cooperation among ecosystem participants. For example, Amazon's Fire OS and Alibaba's AliOS, both forks of Google's Android operating system, influenced the Android Open Source Project (AOSP) community. Such forks can be viewed as a form of disagreement between competitors that influences their cooperative strategies. Handset manufacturers such as Acer and Samsung must determine if they want to remain a part of Google's dominant ecosystem through exclusive agreements via the Google-founded Open Handset Alliance or break away and form alliances with competitors such as Alibaba in China's emerging market[3]. Participants in other types of innovation ecosystems can often deploy strategies that are reminiscent of forking such as developing alternative specifications within standard-development projects or even spinning off new technology consortia as in the case of the Blu-Ray Founders Group spinning out of the DVD Forum. Thus, conflict can inform subsequent cooperative strategies between the conflicting parties themselves, with complementors and even among complementors, thereby shaping ecosystem boundaries and innovation outcomes.

Based on these observations, decisions to cooperate in open innovation ecosystems account for strategic resource allocations and competitive interactions (cf. Leiblein et al. 2018, Hoffman et al. 2018). They are driven by opportunities to create and appropriate value from

[3] https://arstechnica.com/gadgets/2018/07/googles-iron-grip-on-android-controlling-open-source-by-any-means-necessary/. Retrieved February 7, 2019

interdependencies despite the potential for conflict. These arguments resonate with the views expressed by Leiblein et al. (2017): cooperative decisions in open innovation ecosystems are *intertemporal* because past innovations influence current conflict and subsequent innovation opportunities, and they are *interorganizational* because they impact many members of the innovation community. Furthermore, as envisioned by Prahalad and Hamel (1994), industry structure may be viewed as a variable to be managed, rather than accepted as a given (Pisano and Teece, 2007). Thus, shaping innovation ecosystems must be considered a critical goal of strategic cooperative action.

In this paper we explore the strategic interplay between conflict and cooperation among firms participating in open innovation ecosystems. In these ecosystems, varying degrees of technological complementarities and associated interdependencies change the calculation of private, club, and public benefits and, hence, when to cooperate and how to respond to conflict. We ask how disagreements affect subsequent cooperative behaviors of firms within open innovation ecosystems, not only in terms of how cooperation between the conflicting parties evolves after such contests, but also how the cooperative responses vis-à-vis other ecosystem participants evolve. To address this question, we offer a conceptual model for how conflict and cooperation unfold within open innovation ecosystems. We argue that the dear enemy effect, or the way in which conflict arises but is accommodated is plausible when contestation is driven by an increase in the private and club value of the shared technological resource. While participating firms are often rivals in their product or service markets, the ultimate value of the system depends on their complementary technologies or some foundational technology such as an operating system on which they build their products (Delcamp and Leiponen 2014, Fershtman and Gandal 2011, Rosenkopf et al. 2001, Vasudeva et al. 2014). Accordingly, more value from the contested technology may be created and leveraged through continued cooperation than by exiting a cooperative relationship or adopting an adversarial position (Heller and Eisenberg 1998, Shapiro 2000). Cooperation in such settings can take various forms such as co-specialization or co-development of additional complementary technologies and products (Teece 1986, 2009). Firms may even increase their cooperative efforts with an aggressor and concurrently create new cooperative ties as a response to evolving technological and market opportunities. Moreover, a dual strategy that entails a firm's efforts to build complementarities with other ecosystem participants even while continuing to cooperate with an aggressor could attenuate the likelihood of future conflict.

2. Dear Enemy: Cooperation between Rivals in Conflict

We define open innovation ecosystems as constellations of firms and other organizations who engage in open innovation practices such as technology licensing, collaborative R&D arrangements, open-source development, or corporate venturing and spinoffs (Chesbrough 2003). Such constellations can be formal organizations such as standards development organizations (Leiponen 2008), or alliance networks involving organizational and social interactions (Powell et al. 1996, Vasudeva et al. 2013, Rosenkopf et al. 2001). Our conceptualization that accounts for public, club and private benefits departs from prior definitions according to which open innovation necessitates that "all information related to the innovation is a public good—nonrivalrous and nonexcludable" (Baldwin and von Hippel 2011: 1400). One common feature among the varieties of ecosystems is that "they help coordinate interrelated organizations that have significant autonomy" and that they are "enabled by a modular architecture" (Jacobides et al. 2018: 2260). Modular architectures necessitate broad agreement about how technology modules relate to one another. Ecosystems provide the processes and rules so that firms can define modular interfaces, which simplifies ongoing coordination. Within modules, firms have the freedom to operate as they see fit as long as they adhere to an ecosystem's predefined standards and rules (Jacobides et al. 2018).

Within this framing of open innovation ecosystems we explain the existence of dear enemy recognition that involves sustaining cooperation even after outright conflict between its members. The notion of the dear enemy effect originates from an early literature in evolutionary biology, but similar behaviors have been highlighted by subsequent game-theoretic models within the social sciences. The evolutionary biology literature observed that despite direct competition for resources, space, and partners, territory holders often show reduced aggression towards their recognized neighbors (e.g. Getty 1987, Jaeger 1981, Temeles 1994). It is explained as an evolutionary response to the high costs and low payoffs of aggression towards territorial neighbors, for aggression under repeated interaction can simply exhaust resources without improving strategic positioning within the territory.

A parallel literature on the evolution of cooperation has found that in repeated prisoner's dilemma games, cooperative interactions in animals and humans alike can emerge based on the principles of mutual gains, kinship, and reciprocity (Axelrod and Hamilton 1981). The greater the shadow of the future (probability of repeated interaction) and the cooperative payoffs, the more likely that cooperation rather than defection or exploitation will emerge as the stable equilibrium (Axelrod 1984). In a nutshell, cooperation may prevail even after conflict when ecosystem members are interdependent over the long term and when cooperation can create substantial benefits. In this section, we first explore the roles of private, club and public benefits and the degree of technological complementarities. We then explore the impact of the ecosystem network structure on the response to conflict and highlight the implications for ecosystem boundaries.

2.1 The interplay between private, club and public benefits

Open innovation based on co-creation activities tend to generate public, club and private benefits for the participants (Khanna et al 1998, Ostrom 2000, Farrell and Simcoe 2012). Strategic management research on open innovation ecosystems generally considers only public and private benefits in determining how firms create and capture value in such ecosystems (Chesbrough 2003, Alexy et al. 2009, Pisano and Teece 2007). Firms may participate in open innovation ecosystems with the goal of benefiting from the public good created in the form of shared infrastructure and innovation that is available to all members of the ecosystem. Alternatively, open innovation may result in truly non-rivalrous and non-excludable public goods such as open source software and open science (von Hippel and von Krogh, 2003). By definition, public benefits accrue to everyone in the ecosystem, independent of their contributions to a specific project. For example, anyone in the industry could access some of the technical solutions developed by participating organizations through technological spillovers. Private benefits, in contrast, include potential royalty income for licensed patents and early-mover advantages in subsequent product markets. Firms' contributions to such open innovation ecosystems usually hinge on such private rewards from participation that complement the public good innovation and outweigh the potential rewards incurred from free-riding or going-it-alone (Chesbrough 2003, Baldwin and Clark 2006).

Additionally, outcomes of collaborative innovation can be described as club goods (Buchanan 1965, Olson 1965) when contributors receive the value of the whole innovation while incurring a fraction of the cost. Club benefits are available to sub-groups of firms that pool their complementary technologies to create mutually beneficial innovations. These profits from innovation are shared with partners that are important for commercializing the technology (Teece 1986). Technological complementarities among the contributors, that often arise from the modularity that is designed into the ecosystem (Jacobides et al. 2018), can facilitate the creation of club goods when the inputs are combined in a way that generates specific benefits for the contributors themselves. For example, the contributors can create shared technologies that are particularly valuable in the context of their own market positions. Thus, alongside the broadly available public benefits and firm-specific private benefits, innovators can gain significant club benefits (Lerner and Tirole 2002, Vasudeva and Teegen 2011, Baldwin and von Hippel 2011).

Private benefits and club benefits, however, are only obtained when firms contribute to co-creation because these contributions enable firms to shape the technical solutions in a direction that favors their own technological and market features. Moreover, contributions involve a substantial development cost. If firms cooperate to develop mutually beneficial technological features resulting in club benefits, they can share the development cost with peers.

Freeriding in a manner that evades the development and coordination costs to receive just the public benefits provides an appealing option if the private and club benefits are not very large and the costs of development are high. Yet, if all firms choose to freeride, no public, private or club goods are created. It is thus in the long-term interest of firms in the ecosystem to cooperate, but cooperation among firms can fall apart as they compare their immediate payoffs against expected (and discounted) long-term payoffs. In this case, one of the firms may still undertake solo development and appropriate private benefits while generating some modest public benefits. In contrast, when the club benefits are large, providing opportunities to create and capture value through technological complementarities among the contributors, the cooperation strategy dominates. The relationships between the three types of benefits and the costs of cooperation thus determine whether the dominant strategy involves cooperation or freeriding in an open innovation ecosystem.

2.2 Sources and effects of conflict in innovation ecosystems

For the purpose of our conceptual framework, we assume that conflict concerns disagreement about the future evolution of the market, whereas negotiation is a regular and frequent aspect of business interaction that enables companies with conflicting interests to attempt to arrive at a mutually beneficial business arrangement. For example, when firm A is interested in buying products or services of firm B, it can make an offer to buy, which B can counter with a different offer, and if the acceptable terms to each party are not too far apart, they may include additional features in the negotiation to find compromise. If no compromise is feasible, the parties will simply walk away. In contrast, conflict entails greater disagreement than regular negotiation. Conflict is a situation where, for example, firm A and firm B had a supply agreement, but end up with different interpretations of the terms. A may claim B has supplied too little quantity or defective quality. To end up in conflict, firms usually have an existing business relationship but suddenly, due to some unforeseen emerging circumstances, disagree about the terms of the agreement. In high tech industries such as electronics, conflict often involves disagreement about access to and investment in intangible knowledge-based assets, manifested in intellectual property such as licensed software or patented inventions.

For instance, litigation about intellectual property rights and licensing terms or disagreements about the direction of technology development may signal the evolving value of the underlying technological or commercial assets, driving the ecosystem participants to attempt to appropriate more private value. In standards co-development, conflict can also emerge from concerns about the erosion of existing technological or competitive positions through ecosystem level changes. Ranganathan et al (2018), for instance, find that such competitive concerns impact cooperative behavior contingent on the structure of interdependencies in technological, commercial, and relational spaces. Similarly, open source software projects that usually operate under very permissive licensing models are not insulated from disputes concerning compensation, intellectual property, and opportunism (O'Mahony 2003). Such projects often encounter challenges associated with design and production costs, as well as the costs of communication and coordination across organizations (Baldwin and von Hippel 2011).

In all such situations, conflict fundamentally arises from the confluence of incomplete contracts and unforeseen market or institutional circumstances that increase the transaction costs (Arrow 1962). For example, conflict between two firms within a larger ecosystem may force attention toward an unanticipated change in the value of the underlying technological assets. However, if the disagreement and new valuation only affect the level of public benefits and do not alter the cooperation payoffs, then we should see no change in subsequent cooperation. For instance, the value of one firm's IP may rise and create conflict when determining licensing fees. Higher licensing fees may reduce an ecosystem's public benefit. While this might seemingly push a firm toward less cooperation, a technology user will obtain the reduced public benefit independent of whether they cooperate with the IP holder. Thus, the reduction in the public benefits or increase in the licensing fee does not necessarily impact the incentives to cooperate. Ultimately, if disagreement only influences the value of public benefits, we expect to see no impact on subsequent cooperation.

In contrast, if disagreement shapes the private or club benefits or costs of cooperation, we can expect subsequent cooperation activity to change. For example, in a licensing arrangement, the disputed resource is of continuing value to the licensee of a technology when it has become widely adopted and central in the ecosystem, and when the licensee's own products utilize and depend on that technological resource. Then, such inherent complementarities among inputs in the ecosystem make it more lucrative for the licensee (and perhaps other firms in the ecosystem) to develop additional complementary features that enhance the appeal of the system. In other words, when technologies or features are complementary (in the sense of supermodularity, cf. Topkis 1998, Milgrom and Roberts 1990), exogenous increases in the value of one feature will enhance the returns to improving other, complementary, features. Similar complementarities in value can be seen between hardware and software products (Gandal et al. 2000): When software and hardware are complementary in consumption, diffusion of hardware makes it more profitable to improve and supply complementary software, and vice versa. Thus, by expanding cooperation with the resource holder or licensor, the licensee may be able to create and appropriate some club benefits from the technological system that is now becoming more valuable as a whole. Similarly, from the licensor's standpoint, cooperation increases the supply of complementary technology while reducing the likelihood that the licensee will develop competing alternatives or form alliances with rivals.

Cooperation thus expands the scope of complementary elements in the system, and thereby enhances the club benefits for both the technology owner and the licensee. A cooperative approach may also allow the licensee to convert a one-way complementarity, whereby the licensee's product utilizes the owner's technology, to a two-way complementarity, such that the original resource holder (and aggressor) also becomes dependent on the licensee's resources (Jacobides et al. 2018). Returning to Google's example of locking-in manufacturers that seek to license its 'killer apps' for their mobile devices, manufacturers that co-specialize so that Google depends on their technological resources for its own success could foster mutual forbearance that reduces the possibility of future hold-up (Shapiro 2000, Oxley et al. 2009; Casciaro and Piskorski, 2005).

To sum, akin to the dear enemy recognition in biological ecosystems, cooperation becomes the optimal response to disagreement for firms that have experienced conflict over valuable resources, but are also engaged in the development process for future generations of the contested resource. If the cause of the conflict is that the disputed resource has appreciated in the shared ecosystem, firms are likely to not only accommodate such changes, but even find opportunities for additional investments in complementary specifications. If this is the case, we might see an *increase* in cooperative effort after conflict. In contrast, if the conflict is caused by the disputed resources having depreciated in the ecosystem, we should see a *decrease* in cooperative effort after conflict. These arguments thus qualify existing social network theories that suggest that conflict should lead to a severing of cooperation (e.g., Greve et al. 2010, Fauchart and von Hippel 2008). We propose that technological conflict in an innovation ecosystem may increase or decrease subsequent cooperation between the parties to the dispute, depending on whether the conflict is driven by appreciation or depreciation of the disputed resource.

Next we explore the contingent roles of the degree of technological complementarities between the contestants and the relational dependency that could alter the manner in which cooperation evolves, as well as implications for private and club benefits from such cooperation. A key idea underpinning our conceptual framework is that whether and when intermediate benefits in the form of club benefits arise in addition to idiosyncratic private benefits is a function of the nature of social and technological interdependencies among participating firms.

2.3. The Role of Technological Complementarities

The degree of complementarity varies by technological endowments and strategic positioning in the ecosystem. For example, in the wireless telecommunication ecosystem, telecommunication service providers (operators) are highly complementary with telecommunication network equipment providers. Telecommunication service providers focus on servicing their end users and rarely invest in R&D to build the necessary technological prowess to also build their own networks (Leiponen, 2008). Although telecom network equipment and terminal (handset) equipment are complementary in use, firms can strategically position themselves as specialists of either type of equipment or as providers of both. In deciding their market offering, they also select their direct rivals. However, when co-creating ecosystem resources, firms are stuck with the chosen technology and product portfolio, at least in the short term. In such large technological systems with abundant complementarities, competition shifts toward coopetition.

An instance of conflict such as litigation can be viewed as a competitive action intended to enhance the firm's own profits while also increasing the costs or decreasing the benefits of rivals. The coopetition perspective does not examine how subsequent cooperation is affected by attempts to increase profits through engaging in explicit conflict. In the preceding section, we argued that conflict may increase cooperation between the parties in the co-creation process if disputants perceive benefits from developing resources that complement the disputed resource. The potential for cooperation should become even stronger for technologically complementary firms (Bar and Leiponen 2014). Firms that occupy technologically complementary positions can more easily develop innovative combinations and hence enhance the scope for club goods. In contrast, firms that are direct rivals that offer technological substitutes may find it more difficult to jointly generate new combinations. Similarly, firms that are technologically unrelated have little opportunity to create club benefits.

Technological complementors are also less likely to directly compete within each other's technological or product market space. Complementors are less threatening partners because technological capabilities are highly path dependent (Helfat 1994, Stuart and Podolny 1996), and hence not easily redeployed in another firm's market if they have not started to build such capabilities a long time ago (Sakhartov and Folta, 2014). Thus, if the dear enemy effect supports cooperation even among direct rivals (Polidoro and Toh 2011), then firms will likely become even more lenient toward their complementors. Hence, when conflict arises because the value of the contested resource has increased, technological complementors will respond particularly cooperatively.

2.4 The Role of the Network Structure

The response to a conflict unfolds within a network structure of cooperation surrounding the adversaries (Axelrod 1984). As hypothesized by Gnyawali and Madhavan (2001), the network structure is likely to moderate the competitive interactions of firms. We highlight two potential network implications of conflict within an open innovation ecosystem: activation and enhancement of outside options, and the opportunity to exact collective punishment of the source of conflict.

First, the cooperative payoffs of the user of the disputed resource may depend on the extent of its interactions with the resource holder and other ecosystem participants. A firm with many cooperative ties is likely to have greater freedom to adjust its cooperative strategies when conflict arises with a resource holder, whereas a firm with few ties is more dependent on an adversary. As the user's collaborative activities with other firms increase, its dependence on the resource holder is reduced. In large measure, the relational dependency of the firm hinges on the social networks and informal ties between the engineers and inventors who participate in the co-creation process (Dokko and Rosenkopf 2010). When a firm is less dependent—that is, more central within a cooperative network—it implies the firm has greater trust, reputation, and influence within the ecosystem (Gulati 1995). Firms in that position could redirect co-creation activities away from the adversary by building alternative coalitions that constitute outside options (Simcoe 2012, Ranganathan and Rosenkopf 2014, Ranganathan et al. 2018). However, firms who are more dependent may find it necessary to continue working with an aggressor because there are no outside options that provide greater benefits.

Regardless of relational dependence, participants may expand their cooperation with existing partners or forge new relationships as a deterrent to an aggressor. A challenge initiated by a resource holder might encourage cooperation particularly between users of that resource. Although new cooperative ties may serve to counterbalance the aggressor over time and provide greater options if conflict arises again, such ties are conditioned on the degree of partner-specific human and technological assets, which can be redeployed to create synergies with other participants in the ecosystem when such asset specificity is low (Poppo, Zhou and Zenger 2008).

Further, as the resource holder attempts to appropriate a larger share of the ecosystem value, the resource users or licensees may be encouraged to undermine the adversary and attempt to circumvent the disputed resource. Evidence of such behavior from other ecosystems suggests firms may attempt collectively punish or ostracize aggressors (Ostrom et al. 1992; Hirshleifer and Rasmusen 1989). To increase their ability to do so, disputants may pursue arrangements that broaden the innovation opportunities and reduce the likelihood of being “fenced in” (Ziedonis 2004). Outside options thus reduce the technology user’s dependence on the resource holder and thereby enhance their bargaining position within that relationship (Davis 2016). Thus, cooperation among technology users may increase following conflict to undermine the technology holder's bargaining power.

2.5 Beyond Dear Enemy: Crossing Ecosystem Boundaries

Apart from the benefits of the cooperative response which we have described in the preceding sections, ecosystem participants that are subject to a conflict may also consider other types of strategies that involve reshaping the ecosystem boundaries. Although leaving an ecosystem may not be a feasible response to conflict because members may depend on other ecosystem participants for resource access, conflict situations could encourage the ecosystem participants to adjust the boundaries of the innovation ecosystem and the degree of openness. The open innovation literature has recognized that co-creation networks often involve varying degrees of organizational, technological, geographical and institutional boundary-spanning which in turn affect the extent to which innovation follows tightly coordinated and managed versus distributed and loosely coupled approaches (Gulati et al. 2012, Vasudeva et al. 2013). Such variations could impact the boundaries of the ecosystem in terms of inclusiveness and mobility and hence the overall degree of openness. When the ecosystem boundaries are highly porous—that is, entry and exit across ecosystems is feasible and frequent and there is high turnover of participants—the targets of aggression may adopt a strategy of enhanced mobility and even switch to a competing ecosystem (Simcoe and Watson 2019). Such high mobility requires that other ecosystems are able to provide reasonably close substitutes to the resources available in the focal ecosystem. Conversely, if the constellation of resources within the focal ecosystem is highly specialized, or if the governance mechanisms imposes sanctions on the departed, mobility may not be high even if boundaries are not restrictive.

For example, conflict within one open-source software project might induce participants to leave and join other software projects or fork an operating system so that no participant has significant power to coerce others. Forking is an opportunity to rearrange the way private, club, and public benefits play out in an ecosystem, especially when the existing value capture in the form of club benefits derived through complementarities is minimal. Interestingly, forking is a key right in the free/open-source software community. The GNU Operating System sponsored by the Free Software Foundation states that free software implies freedom to run the program as one wishes, study it, change it, and redistribute copies, including modified versions.[4] Similarly, Debian Free Software Guidelines[5] and the distribution terms of the Open Source Initiative[6] state the right to fork as a key element of open-source software licensing. Open-source software communities have thus recognized that adjustment of the boundaries of the community is a precondition for innovation and evolution of the technology. This is in contrast to the conditions in the licensing agreement for Android (which by this definition is not truly open source) to forbid forking of the software. In other words, Google uses its platform power to prevent participants from diluting its control of the system, specifically, its ability to include key applications such as search and browser on each mobile device. In particular, if European device vendors want to use a forked version of Android that allows other search and browser apps, they have to pay a licensing fee.[7]

Furthermore, ecosystem participants might attempt to dilute the power of the key resource holder by inviting entry into the system and redirecting efforts in a direction that

[4] http://www.gnu.org/philosophy/free-sw.en.html Retrieved February 2019.
[5] https://www.debian.org/social_contract#guidelines Retrieved February 2019.
[6] https://opensource.org/osd-annotated Retrieved February 2019.
[7] https://venturebeat.com/2018/10/16/google-will-charge-android-device-makers-a-licensing-fee-to-preinstall-its-apps-in-europe/ Retrieved February 2019.

facilitates ostracism of the aggressor and redirects the co-creation efforts to undermine their centrality. Additionally, ecosystem participants could also leverage the coercive power of non-market actors such as governments to restrain the entry of aggressors and thereby, limit their market access unless they agree to the licensing terms that are favorable to other ecosystem participants. Exit, switching, and restricting entry in an ecosystem that alter its boundaries may, thus, constitute additional alternatives for responding to conflict.

3. Theory and Propositions

We propose a novel theoretical framework that begins to unpack the dynamic implications of strategic disagreement and technological cooperation within open innovation ecosystems. Our conceptualization of open innovation ecosystems extends prior approaches whereby open innovation generates outputs from collective efforts that are openly available for anyone to use (e.g. Baldwin and von Hippel 2011). In contrast, we draw attention to the public goods, club goods, and private goods available to participants in collaborative ecosystems.

We argue that conflict about the returns to shared technological resources is common. The value of technologies changes as the dynamics of marketplaces unfold. This leads to disputes, which themselves focus the attention of firms toward their cooperative decisions and how they might realign them. If the conflict only impacts the availability of public goods, we expect no implications for cooperative activities within the ecosystem. In contrast, if private or club goods are impacted, then the payoffs for cooperation may be altered. We highlight two key contingencies that determine the strength of the response, and two strategic outcomes that illustrate the options available within open innovation ecosystems. Figure 1 summarizes these arguments.

Figure 1 insert here

Although studies in strategic management have examined the dynamics of cooperation and competition (cf. Hoffman et al. 2018), these studies have focused mostly on value appropriation in buyer-supplier exchanges (Brandenburger and Stuart 1996) and the competition effects of various dyadic alliances on the broader organizational ecology (e.g., Silverman and Baum 2002, Gimeno 2004). Our conceptual framework departs from these prior works by arguing that competition can trigger conflicts when the parties have divergent expectations about future payoffs. Such conflicts in turn impact how cooperation within open innovation communities evolves for future technological innovation. Below we summarize the main ideas that underpin our conceptual framework and submit propositions.

First, we argue that exogenous market changes over time will affect the value of technology assets that are fundamental to an industry's products and services, which will drive conflict. Moreover, it is important to distinguish whether the conflict was caused by an increase or decrease in the value of a technology: if the value of the disputed resource has increased (the right branch of Figure 1), the technological platform has become more valuable, and the opposite for the decreased value scenario (the left branch of Figure 1). It follows that increased platform value is likely to enhance club benefits, making it appealing for further investment in cooperation, whereas reduced platform value detracts from club benefits and makes further investment less attractive.

> P1: Changes in the value of technology assets in open innovation ecosystems will increase the likelihood of conflict among ecosystem participants.

> P2: Appreciation (depreciation) of technological assets increases (decreases) the likelihood of ecosystem participants' cooperation after conflict.

Second, investments in cooperation are more likely in the context of repeated interactions, where the shadow of the future plays an important role in shaping expectations of future private and club benefits for the participants. An important contribution of our framework is that it separates private, club and public benefits, which contrasts with prior works on coopetition which have generally only specified the tension between private and common or joint benefits in dyadic settings (Parkhe 1993, Khanna et al. 1998, Arslan 2018). This feature of our multipartner setting brings into focus club benefits as an intermediate type of a benefit that is neither firm-specific nor shared by all participants, but arises as a function of technological interdependencies among participating firms. In particular, we develop the connection between technological complementarities and club benefits from cooperation:

> P3: When ecosystem parthers have strongly complementary technology assets, they are more likely to cooperate because of the enhanced potential to create club goods.

Third, our framework extends traditional approaches of coopetition that are motivated by the idea of strategic interdependence between firms (e.g. Dagnino 2009, Gnyawali et al. 2006). We account for the strength and nature of interdependencies within the ecosystem which influence whether and when firms accrue club benefits in addition to private benefits and increase their cooperative activities. Specifically, strong technological complementarities between the parties to the conflict positively moderate the response to enhanced club benefits (the interaction effect of the right branch in Figure 1). Conversely, if firms' technological capabilities are not complementary with the disputed resources, there are few opportunities to expand positive interactions and, therefore, opportunities for additional cooperative activities are limited and we do not expect increased cooperation. In fact, if a firm's technologies are substitutes ("negative complements") to the disputed resource, they may cut ties to the aggressor and attempt to increase the market share of their own technologies.

> P4: When ecosystem partners have strongly complementary technology assets, they respond particularly strongly to the appreciation of the shared technology by increasing cooperative activity.

Similarly, dependence in the network of existing cooperative relationships may moderate the response to the conflict. If the target of the conflict is dependent on the aggressor for cooperative innovation opportunities, the targeted firm is more likely to respond cooperatively, accommodate the conflict, and pursue additional opportunities with the aggressor, because they have few outside options for innovation (cf. interactions between relational dependence and club benefits in Figure 1). However, in both cases of strong interdependencies (technological complementarities and network relationships), the highly dependent party in the conflict may invest in a dual strategy of building other coalitions and even pursue ostracism of the source of the conflict to counteract their influence (the bottom outcome rectangle concerning outside option and boundary management in Figure 1).

> P5: Relational dependency on an ecosystem aggressor is likely to accentuate a cooperative response by the target but also create incentives to develop outside options.

Finally, we developed testable ideas regarding opportunities to manage the ecosystem boundaries to enhance or dilute the power bases of the contestants. In this vein, we combine perspectives from organization theory and propose that open innovation ecosystems resemble meta-organizations which constitute a collection of individuals or organizations that "coexist, collaborate, and coevolve via a complex set of symbiotic and reciprocal relationships" (Gulati et al. (2012: 573). When conflicting parties are unable to achieve the desired cooperation, owing to the technological or relational interdependence described in the preceding propositions, they may attempt to generate additional innovation opportunities by lowering entry barriers into the ecosystem or switching to a different network. In open-source software systems, forking the system is one way of redirecting innovation in the ecosystem in a novel direction, whereas in standard setting, starting a new technology consortium may ensue (Delcamp and Leiponen 2014). In this way, the original aggressor's central position in the ecosystem may be undermined by inviting additional influential collaborators into the network or forking the project and taking it elsewhere.

> P6: Conflict creates incentives for targets to reshape the boundaries of the ecosystem by forking or enhancing entry into the ecosystem to dilute the dominance of the aggressor or to exit the ecosystem.

4. Emerging Research Directions and Conclusion

The propositions above can generate testable hypotheses and lead research on open innovation into new directions. One important area of future research is to develop novel ways to assess and measure the value of technological assets. Such efforts could increase precision in gauging the sources and effects of conflict. One could also examine how, in the event of conflict, cooperative interactions differ depending on whether participants are likely to interact in the future. Future research could hypothesize about conditions when continued cooperation and interdependence becomes more or less likely.

The introduction of club benefits in open innovation ecosystems raises additional research questions. Although club benefits are essential for cooperation to occur, firms must also be able to devise strategies to appropriate private value in interdependent settings. Subsequent research could examine ecosystem conditions or network positions that often lead to greater club benefits. It could also examine conditions under which firms may be incentivized to create public goods even at the cost of short-term private and club benefits.

Additionally, given the transboundary nature of many open innovation systems, researchers could examine how conflict and cooperation in co-creation networks are shaped by national and industry-related institutional factors. The stricter antitrust policies in Europe, for instance, have brought lawsuits against Google's anticompetitive tactics vis-à-vis the licensing of its Android-based apps to manufacturers on the condition that they lock into its platform. Relatedly, although China's weak IP regime and state censorship led to conflict and the subsequent withdrawal of Google from China in 2010, the allure of the Chinese market is known to propel Google towards cooperation with the Chinese government (and by extension Chinese firms) to develop a new censored search engine codenamed Dragonfly that conforms to the institutional demands[8].

In conclusion, we develop a novel framework and offer a forward-looking research agenda to better understand the role of conflict such as legal disputes within cooperative networks in open innovation ecosystems. We draw inspiration from the dear enemy effect elaborated in evolutionary biology and use the economics of repeated games to explain why cooperation occurs among fierce competitors and disputants. The critical factors explaining firms' strategic responses to conflict include whether the driver of the conflict implies that core resources have appreciated or depreciated, and how strong are the technological complementarities and other relational interdependencies among the contestants. Under increasing value of the platform and strong technological complementarities, we may observe that, paradoxically, ecosystem participants increase their cooperation with the aggressors after disagreements.

[8] https://foreignpolicy.com/2018/09/10/google-is-handing-the-future-of-the-internet-to-china/. Retrieved February 7, 2019

At the same time, firms may also deploy additional strategies to undermine the source of the conflict, including building coalitions with other parties or adjusting ecosystem boundaries. We thus identify novel strategic drivers of conflict and cooperation within open innovation ecosystems. We also note a research opportunity to explore how the boundary-spanning nature of open innovation ecosystems, particularly participants' exposure to different institutional environments, influence their cooperative responses to conflict. Although technological ecosystems are often international in reach, there is surprisingly little research that examines the implications of the transboundary innovation and interaction. We encourage future research endeavors to tackle these issues.

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Figure 1 Strategic drivers and responses to conflict in open innovation ecosystems